Executive Summary

Open Systems Ada95 Technology (OSAT) Demonstration

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Background: This effort was initiated in 1996 to support the continued maturation and evaluation of Open System Standards utilization in weapon systems. The goal is to demonstrate and evaluate the American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) Portable Operating System Interface (POSIX) standard Application Program Interface (API) with a commercial off-the-shelf (COTS) operating system and the International Standards Organization (ISO) Ada95 programming language in an embedded avionics strike application, utilizing COTS hardware.

Specifically, this effort converted the F-15 Eagle Runge Kutta Air-to-Ground Ballistic Algorithm to Ada95. This algorithm was integrated with a C language Operational Flight Program (OFP) and C++ Navigation and Communication software. This work was preceded by a Boeing (previously McDonnell Douglas Aerospace) independent research and development (IR&D) flight demonstration project for software reuse on AV-8B, F-15, and F/A-18 aircraft. These components were integrated with Wind River System's POSIX-compliant VxWorks operating system. Components were hosted on a prototype Computing Devices International (CDI) COTS mission computer which utilizes a PowerPC 604 processor. In addition, this effort incorporated a test and flight demonstration of the fault tolerant Joint Strike Fighter (JSF) / The Analytic Sciences Corporation (TASC) Data Fusion Integrity Process (DFIP). The mission computer OFP and the TAV-8B avionics system provided a host for the development, evaluation, and flight test of the open system COTS technology at Boeing and the Naval Air Warfare Center - Weapons Division (NAWC - WD) at China Lake. Flight testing included the release of six Mk76 practice bombs. Flight testing conducted at China Lake range facilities.

The AV-8B platform was used for this demonstration because it's federated avionics architecture is similar to other tactical platforms while still remaining relative simplicity (compared to e.g. F/A-18, F-15, F-16) and also require affordable capability improvements to remain combat relevant. In addition, the TAV-8B at China Lake was readily available for modification in support of a short-turn-around demonstration. This availability at the China Lake NAWC - WD for performing weapons effectiveness demonstrations provided an excellent opportunity to identify problems and solutions with the use of COTS technology based hardware and software. This reduces risk for the AV-8B mission computer fleet upgrade program and ensures that many COTS related issues are resolved by the time JSF begins engineering and manufacturing development (E&MD).

Success of this demonstration may spur other, normally commercially-oriented, vendors to adapt their products for military environments. Conversely, this may identify what the DoD needs to accomplish to adopt COTS. These risk reduction efforts and demonstrations will provide other program managers and engineers contemplating upgrades for mission computer, fire control computer, display processor, and signal processor with enough information to make COTS an acceptable alternative for their weapon system.

The AV-8B Harrier computing resources have reached their limits for throughput and memory capacity, and the software and hardware is outmoded. The Marines, like the Navy F/A-18 and Air Force F-15/16, need to be able to add increased capabilities to counter emerging threats, however, any new functionality requires the deletion of other functionality or the use of primitive assembly language software and tools due to capacity constraints. The solution is to replace the old mission computer hardware and software environments with current COTS technology based processors, backplanes, and the use of modern software engineering tools. Their goals, like those of JSF, will be to achieve long term affordability, portability, scaleability, and reliability through the use of COTS technology and open system standards. However, open systems standards like ISO's Ada95 programming language and the ANSI/IEEE POSIX operating system application programming interfaces had not been previously integrated or demonstrated in real-time an avionics environment. In addition, this program flew a mixed language OFP, demonstrating that Ada95 components can be successfully integrated with C and C++ components, such as may be available as COTS (e.g. from Boeing's Common OFP software library).

Accomplishments:

- Conducted the first operational flight of an OFP written in Ada95.

- Provided a flight-worthy High Order Language (HOL) AV-8B mission computer OFP which performed basic navigation, communications, and Heads Up Display (HUD) functions.
- Added air-to-ground (A/G) ballistics, sensor management, stores management, weapon control and display (C&D), and other HOL software functions to the baseline OFP which enabled the TAV-8B to perform A/G target designations and Auto Mode Constantly Computed Release Point (CCRP) releases of practice bombs.
- Analyzed and enhanced the F-15 Ballistics Algorithm and adapted the modular Ada83 code to run in the mission computer OFP. The Ada OFP components were converted to Ada95.
- Integrated a COTS POSIX-compliant real-time operating system (RTOS) into the mission computer OFP.
- Conducted regression and flight-worthiness testing of the HOL OFP including the Ballistic Algorithm in the AV-8B Manned Flight Simulator (MFS). Testing included simulated, scored bomb releases.
- Installed the mission computer and demonstrated the OFP in the test aircraft; conducted ground testing of mission computer OFP functionality.
- Analyzed the DFIP which was developed during JSF's Software Fault-Tolerance Demonstration (SFTD) program by TASC.

Continuation Efforts (OSAT Phase II):

- Build upon risk reduction successes, include Ada95, POSIX RTOS, mixed language OFP, and COTS processor.
- Demonstrate real-time distributed processing with common infrastructure and components.
  - Use Common Object Request Broker Architecture (CORBA) compliant Object Request Broker (ORB) with POSIX compliant operating system.
  - Integrate a second Power-PC 604 based processing module into the Mission Computer.
  - Show Ada95/C++ interoperabiltiy in a multi-language OFP.
- Demonstrate standards viability, acceptance, and alternatives for multiple platforms and shared memory / message passing.
- Conduct simulator and flight demonstration.